STATUS OF LEVEL 2 PROCESSING

AIRS SCIENCE TEAM MEETING

SEPTEMBER 18-20, 2002

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NASA GSFC Sounder Research Team

OUTLINE

This is a Preliminary Status Report

- Caveats
- Radiance biases vs. ECMWF for clear ocean cases
- IR Tuning Methodology
- Effect of IR tuning on sounding accuracy for clear cases
- RMS sounding errors for cloudy cases
- Biases of clear column radiances vs. ECMWF for cloudy ocean
- Comparison of Total O_3 with TOMS data

CAVEATS

All calculations use pre-launch transmittances -

Frequencies are incorrect

Physics has been improved

"Tuning" to account for systematic errors is necessary

IR channels are treated as "noisy" because of residual computational errors

IR channels receive less weight in the solution

4.3 μm channels currently not used

Effects of non-LTE during day

Retrieval biases increase at night - current tuning insufficient

No angle correction is applied

No first product step is done

Microwave product is used as initial guess

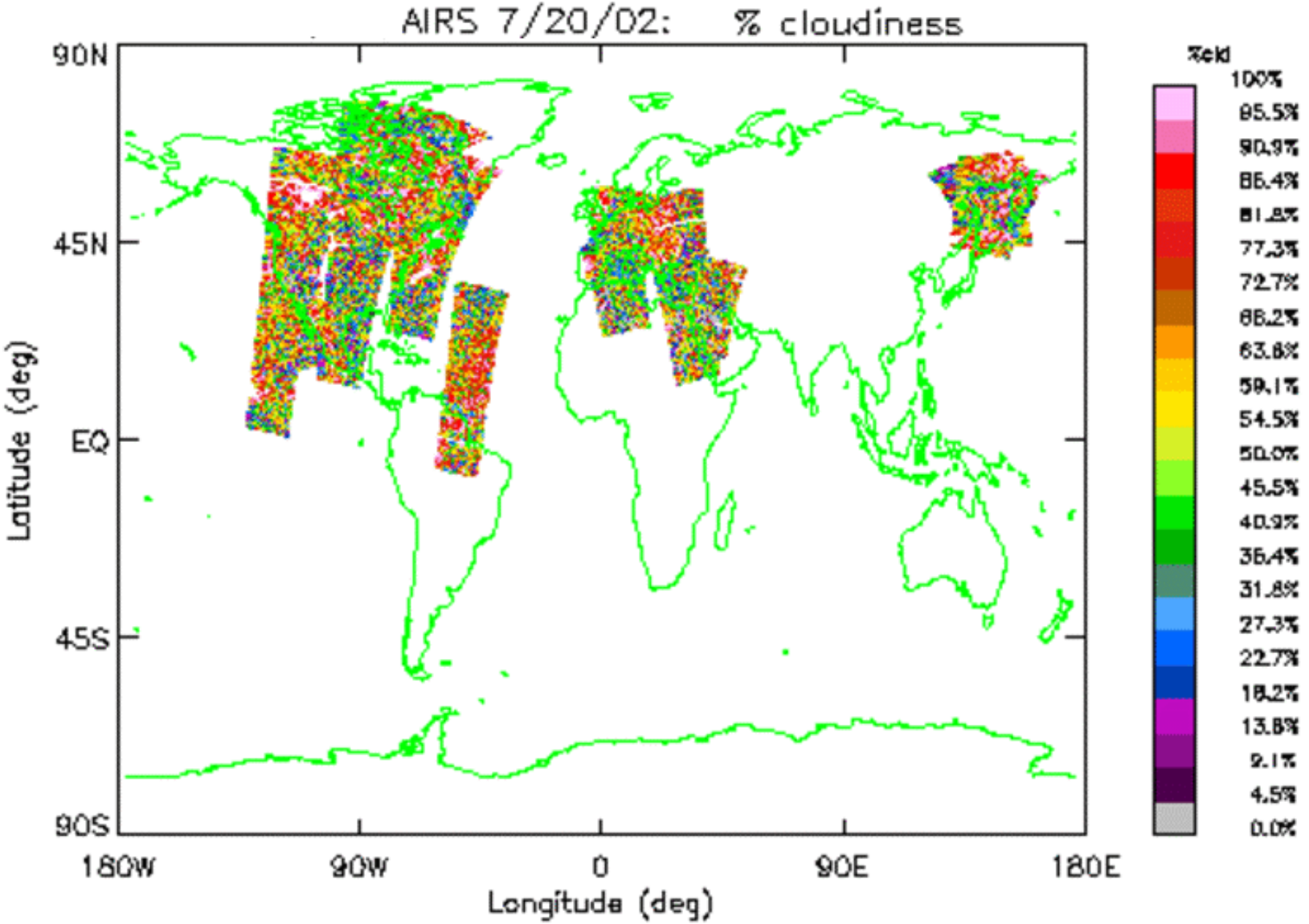
CAVEATS (cont.)

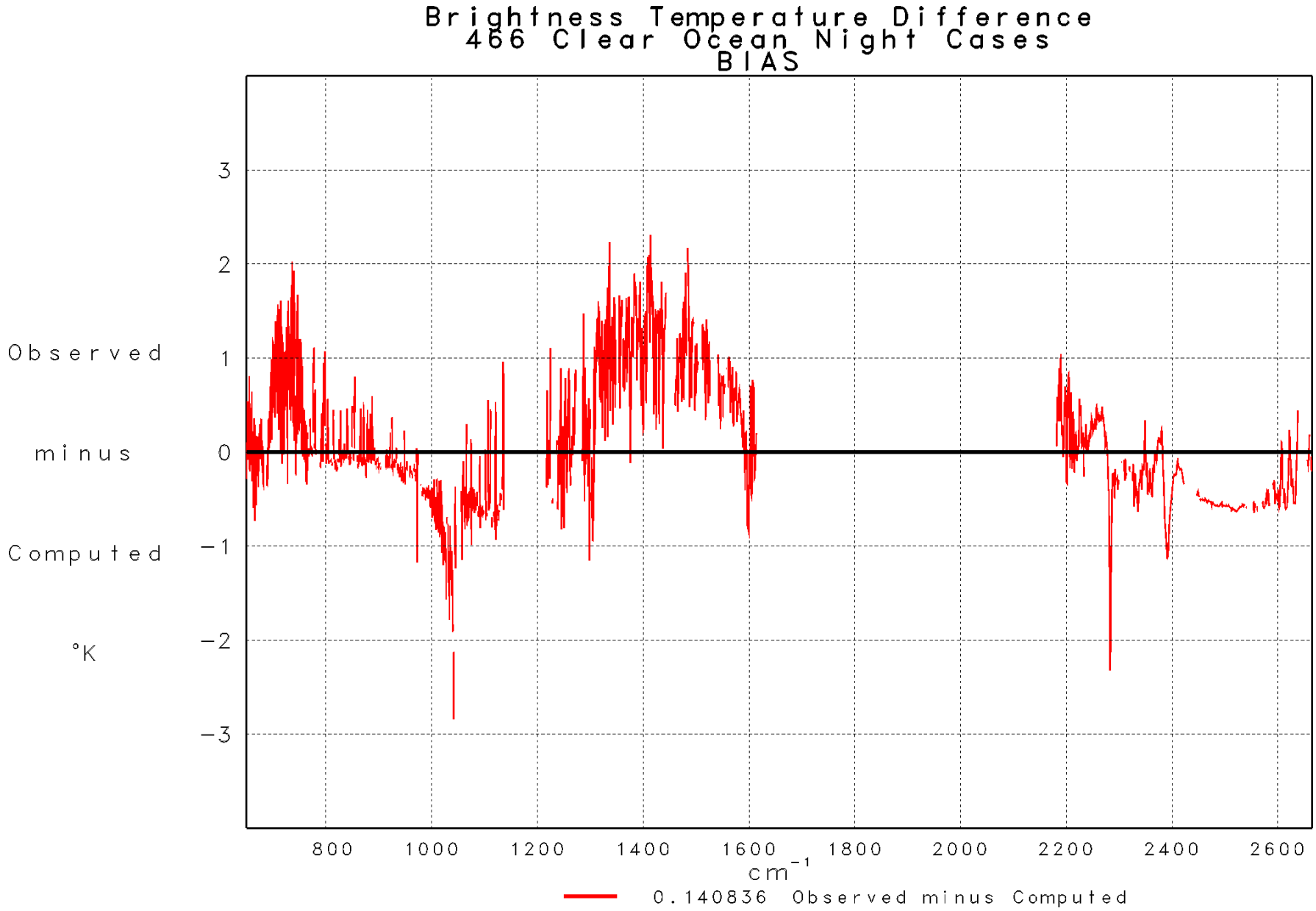
“Errors” are differences from ECMWF forecast

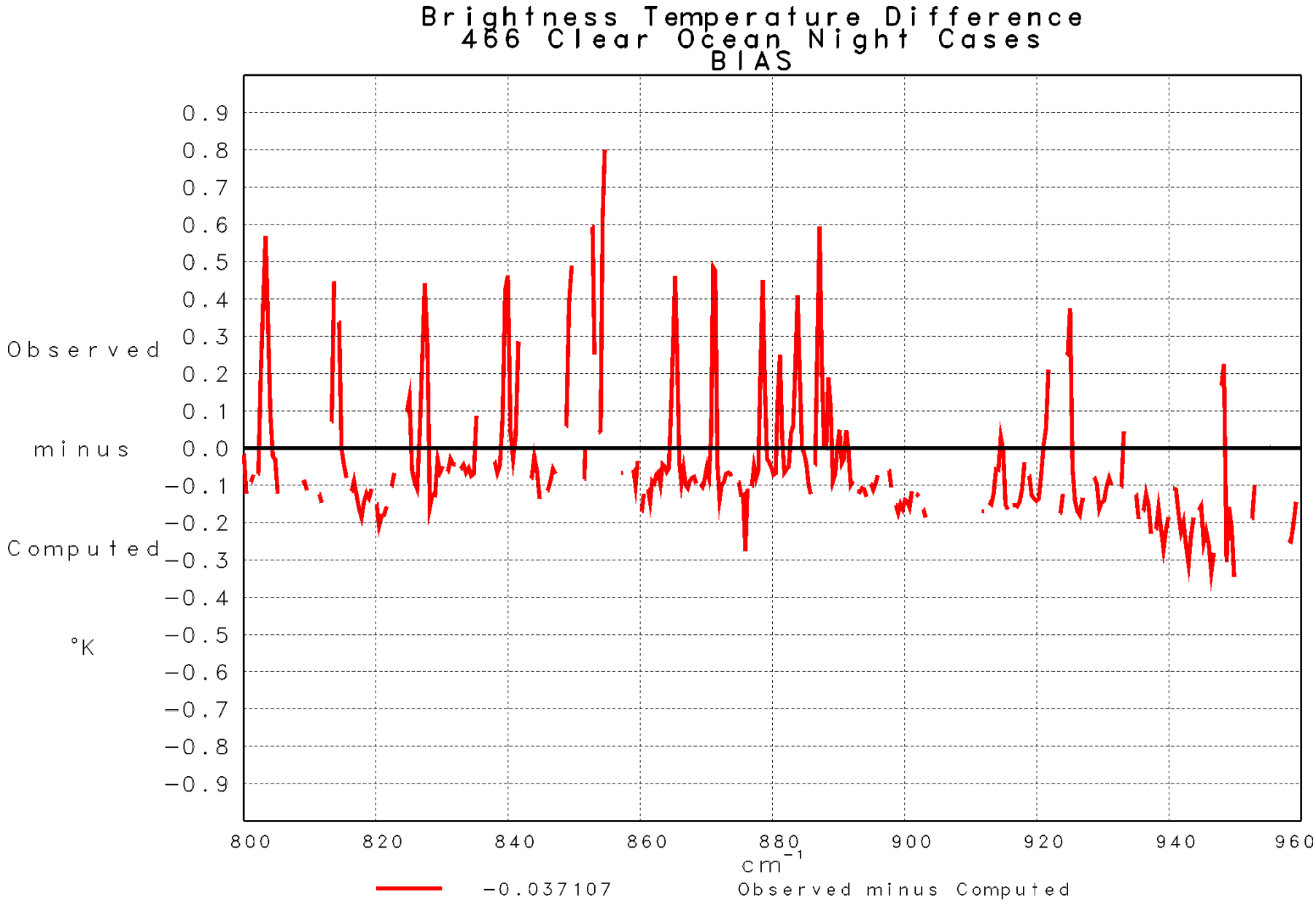
Actual errors are less

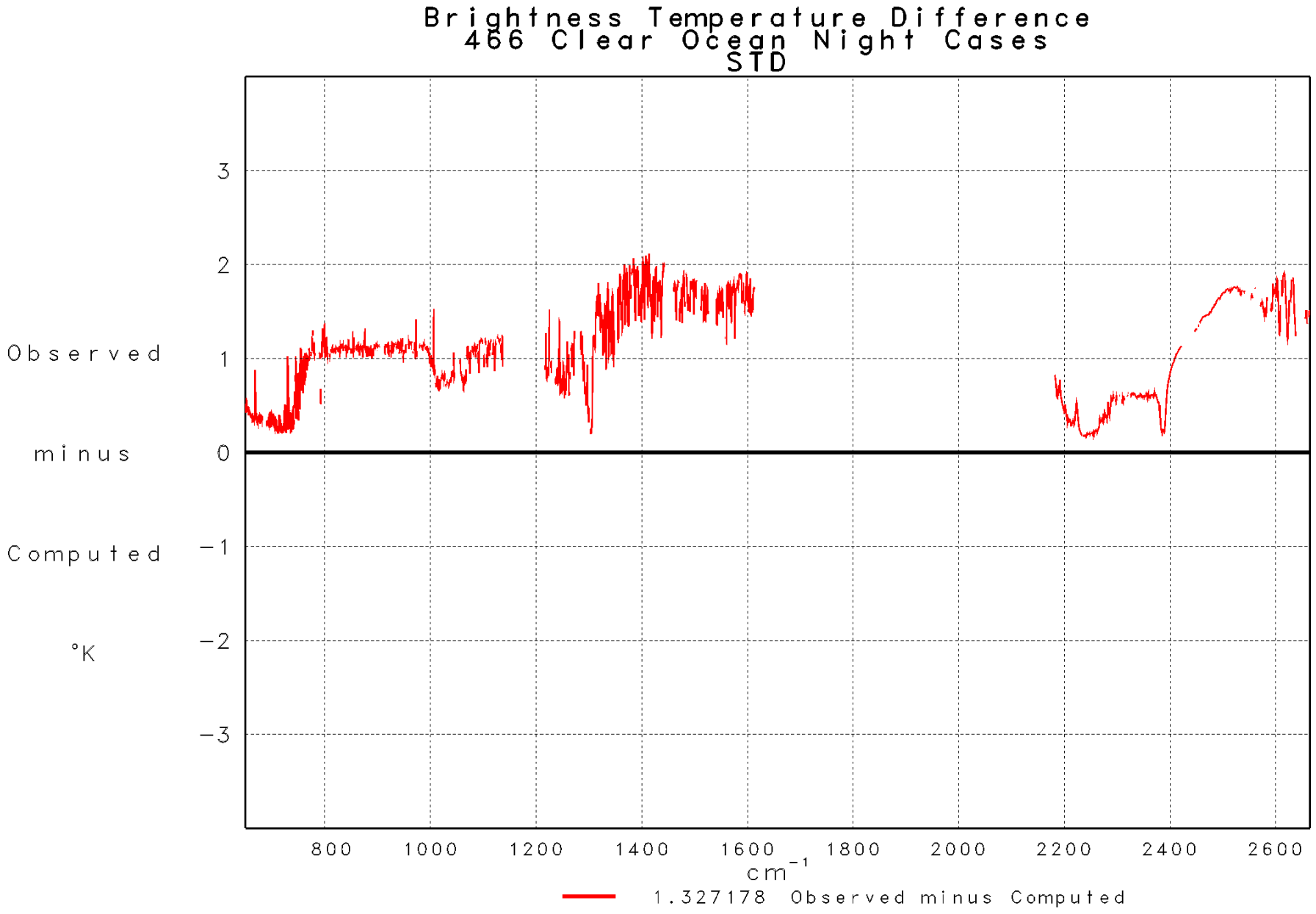
- Forecast is not perfect
- Forecast is every 3 hours - ± 1 1/2 hours from observations
- Spatial structure of forecast is coarser than that of real atmosphere

Errors should eventually be much smaller


AIRS 7/20/02: % cloudiness
90N
45N
EQ
45S
90S
Latitude (deg)
180W
90W
0
90E
180E
Longitude (deg)
%cld
100%
95.5%
90.9%
86.4%
81.8%
77.3%
72.7%
68.2%
63.8%
59.1%
54.5%
50.0%
45.5%
40.9%
36.4%
31.8%
27.3%
22.7%
18.2%
13.8%
9.1%
4.5%
0.0%


Brightness Temperature Difference
466 Clear Ocean Night Cases
BIAS
Observed
minus
Computed
°K
3
2
1
0
−1
−2
−3
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
cm-1
0.140836 Observed minus Computed


Brightness Temperature Difference
466 Clear Ocean Night Cases
BIAS
Observed
minus
Computed
°K
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
−0.8
−0.9
800
820
840
860
880
900
920
940
960
cm−1
−0.037107
Observed minus Computed


Brightness Temperature Difference
466 Clear Ocean Night Cases
STD
Observed
minus
Computed
°K
3
2
1
0
−1
−2
−3
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
cm−1
1.327178 Observed minus Computed

TUNING

Microwave tuning has been discussed at NET Meetings and is in place at JPL

$\Delta\Theta_{j,\ell}$ is tabulated for channel j, beam position ℓ and is scene independent

Standard deviation of $\Theta_{j,\ell} - \Theta^{c}_{j,\ell}$ is constant in ℓ and comparable or less than specified channel j noise except for channel 7, which is not used

IR tuning

Computed based on 466 ocean night 9 spot clear cases based on our clear flag

Minimize differences between observed 9 spot average brightness temperature for channel i, scene k, and brightness temperature computed using colocated ECMWF forecast

Scene independent tuning:

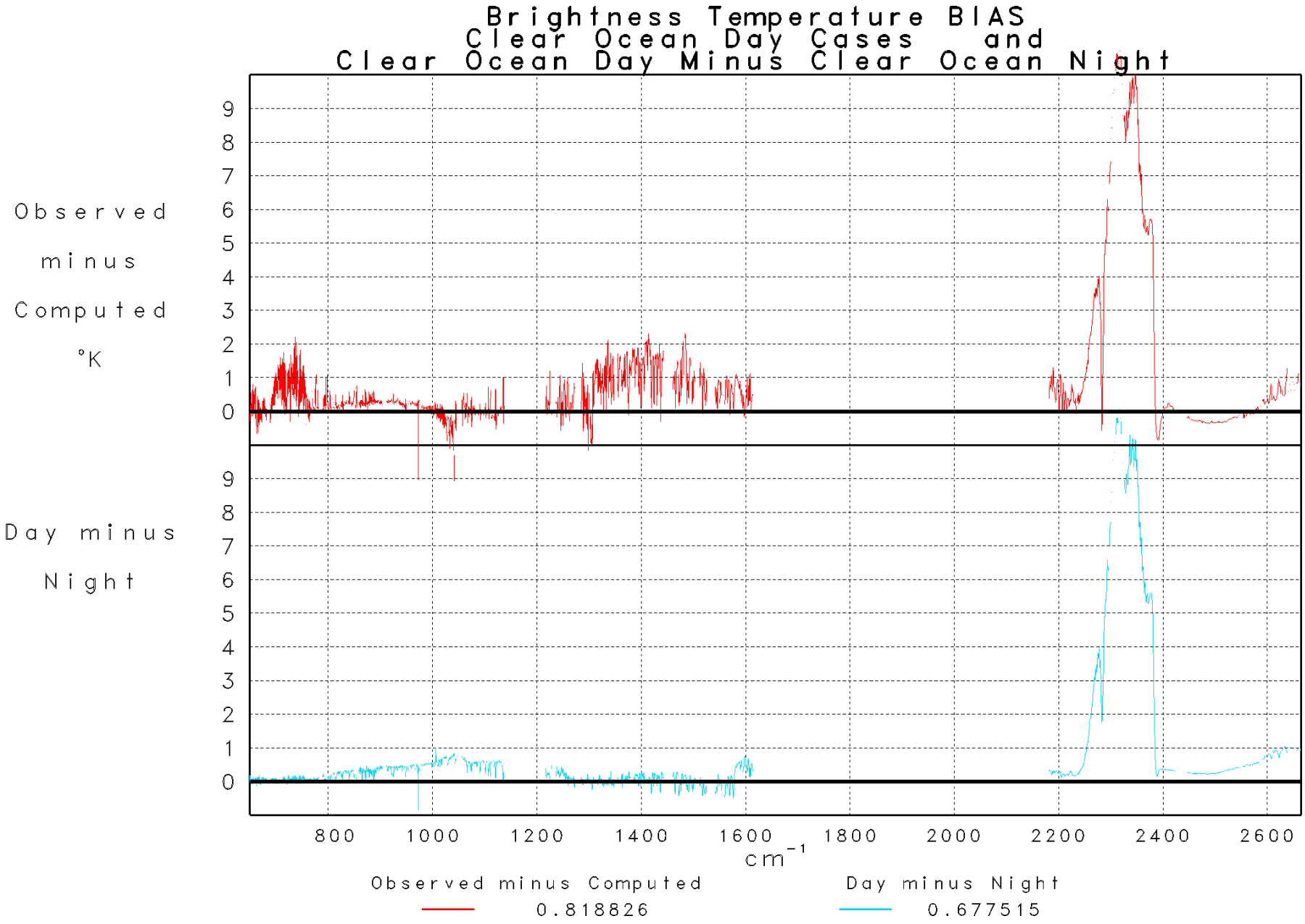
$$\Delta\Theta_{i,k} = A_i$$

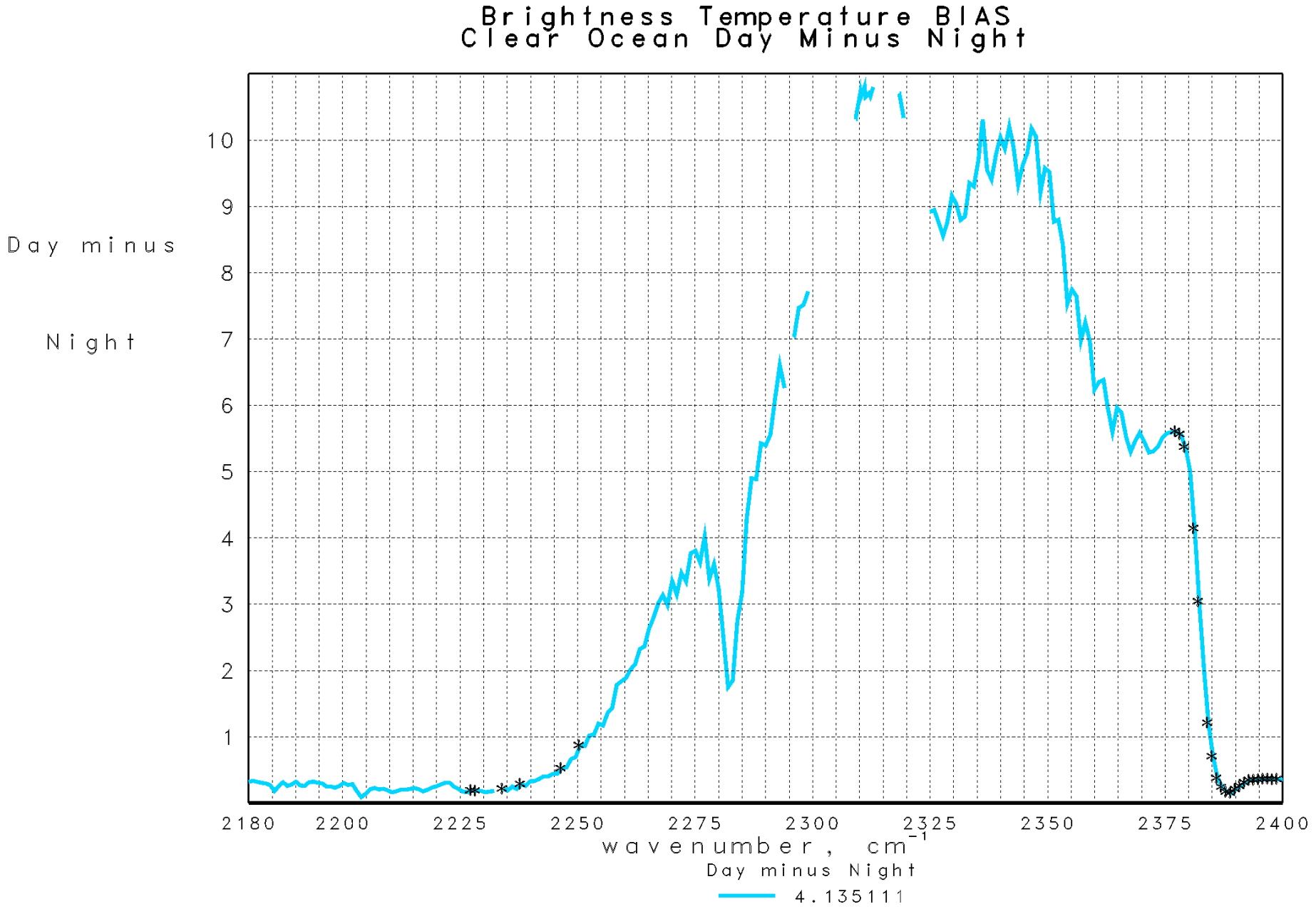
Scene dependent tuning:

$$\Delta\Theta_{i,k} = A_i + \sum_j B_{i,j}\left(\Theta_{j,k} - \overline{\Theta}_j\right)$$ j = AMSU channels 4,5,6,8-14

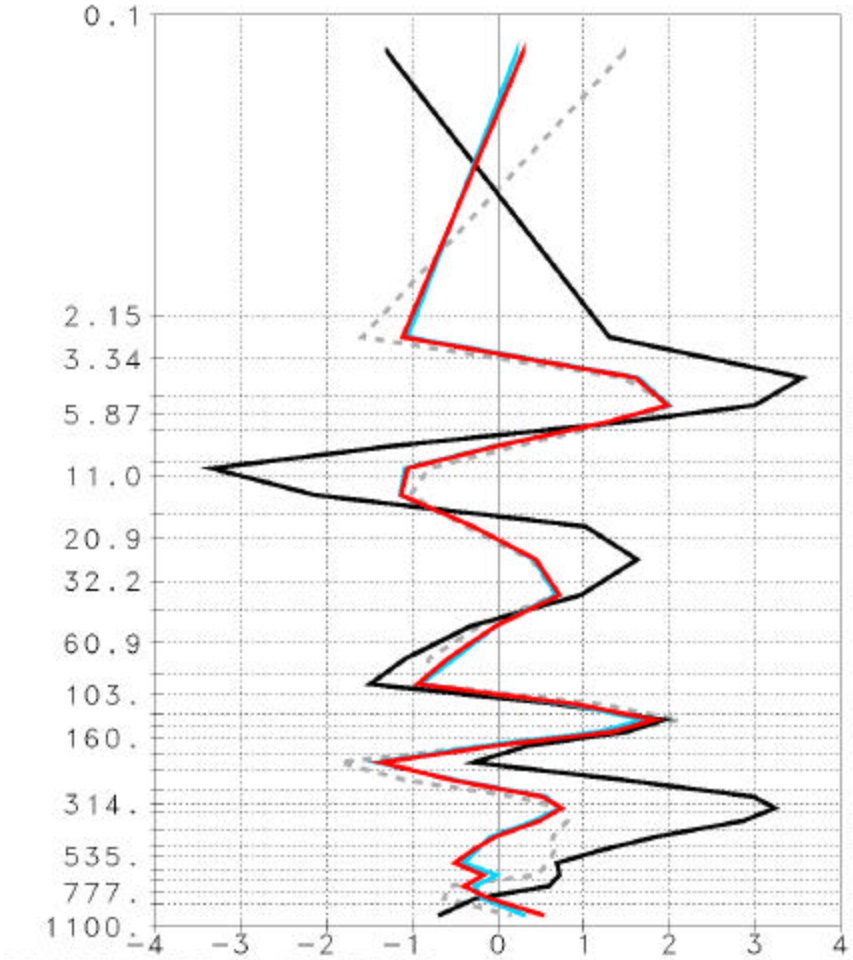
Takes into account temperature profile (lapse rate) and zenith angle dependence of tuning

We refer to these as A_i tuning and $A_i + B_{ij}$ tuning


Brightness Temperature BIAS
Clear Ocean Day Cases and
Clear Ocean Day Minus Clear Ocean Night
Observed minus Computed °K
Day minus Night
9
8
7
6
5
4
3
2
1
0
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
cm-1
Observed minus Computed
0.818826
Day minus Night
0.677515


Brightness Temperature BIAS
Clear Ocean Day Minus Night
Day minus
Night
10
9
8
7
6
5
4
3
2
1
2180
2200
2225
2250
2275
2300
2325
2350
2375
2400
wavenumber, cm-1
Day minus Night
4.135111

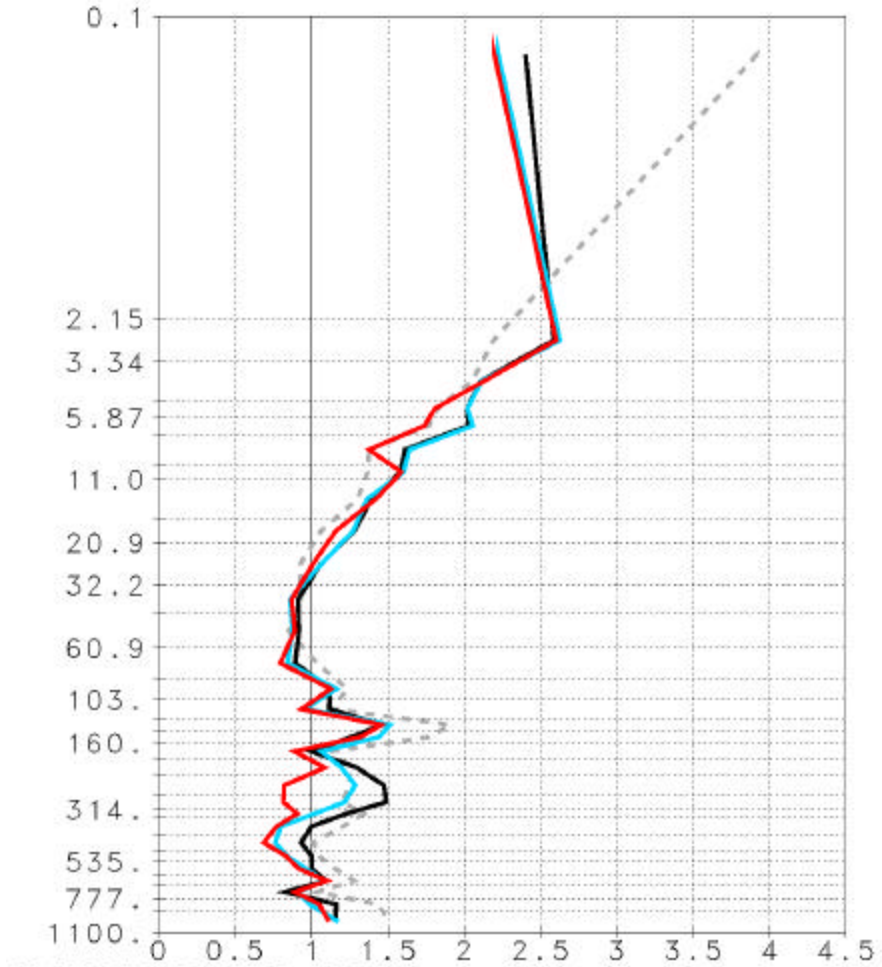
LAYER MEAN BIAS TEMPERATURE ERRORS (°C)
466 Clear Ocean Night Cases



TEMPERATURE BIAS ERRORS

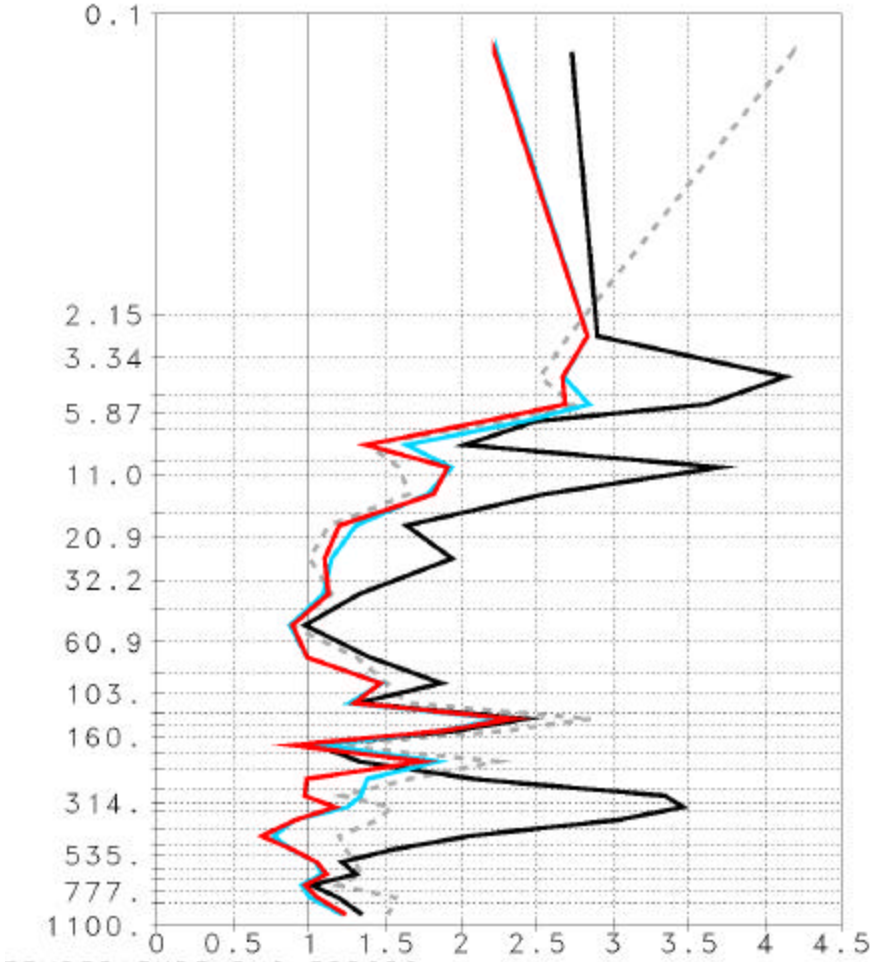
SKIN TEMP	STATISTICS trop	700−surf	
−1.77	0.29	−0.35	Microwave Product
−0.85	1.17	−0.12	Final Product — No Tuning
−0.42	0.15	−0.05	Final Product — A_1 Term
−0.37	0.18	−0.01	Final Product — A_1+B_{11} Term

LAYER MEAN STD TEMPERATURE ERRORS (°C)
466 Clear Ocean Night Cases



TEMPERATURE STD ERRORS SKIN TEMP	STATISTICS trop	700–surf		
2.87	1.56	1.38	---- Microwave Product	
1.79	1.44	1.18	—— Final Product	No Tuning
1.76	1.25	1.06	—— Final Product	A_1 Term
1.40	1.19	1.09	—— Final Product	A_1+B_{11} Term

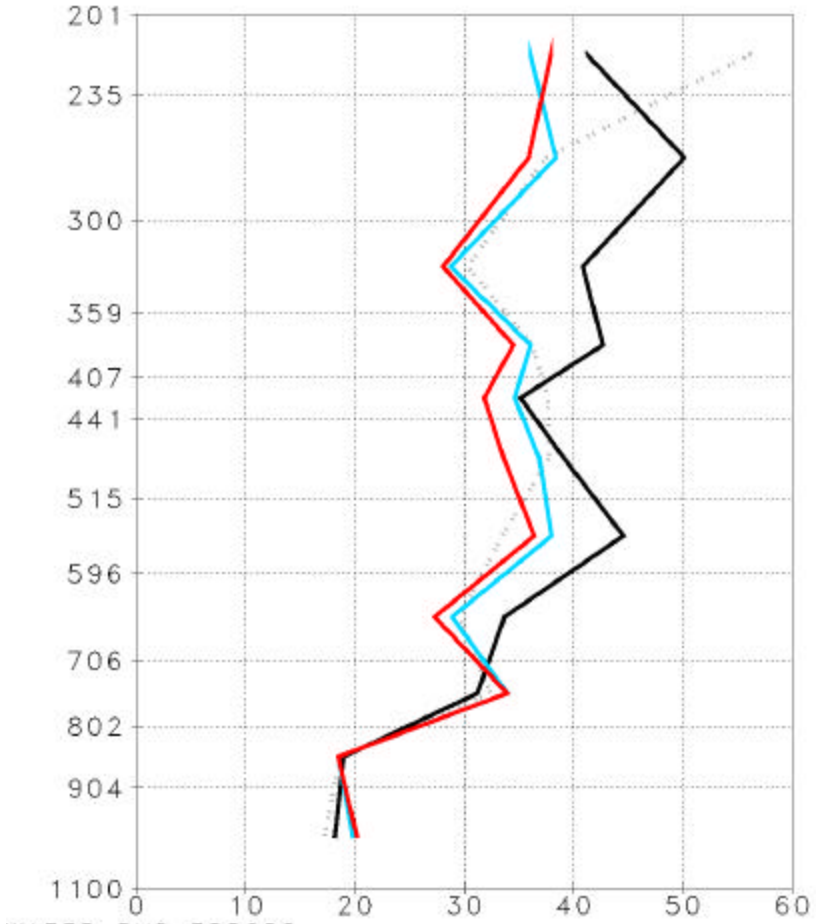
LAYER MEAN RMS TEMPERATURE ERRORS (°C)
466 Clear Ocean Night Cases



TEMPERATURE RMS ERRORS

SKIN TEMP	STATISTICS trop	700-surf		
3.37	1.59	1.43	---- Microwave Product	
1.98	1.86	1.19	Final Product	No Tuning
1.81	1.26	1.06	Final Product	A_t Term
1.45	1.20	1.09	Final Product	A_t+B_{t_2} Term

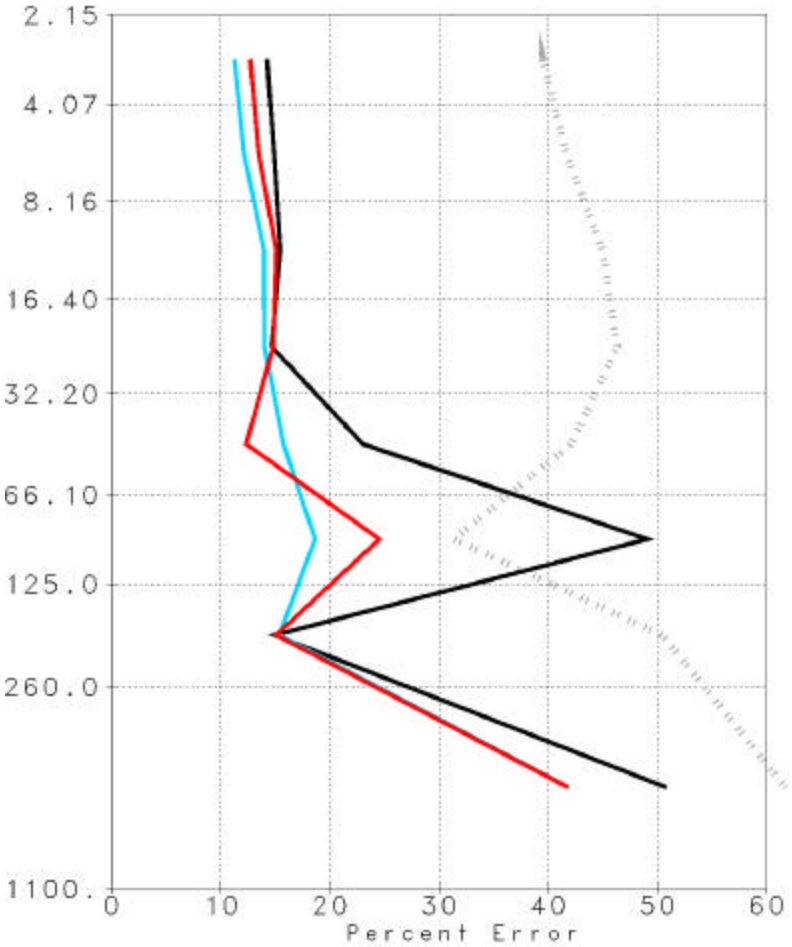
1 Km LAYER PRECIPITABLE WATER PERCENT ERRORS
466 Clear Ocean Night Cases



WATER RMS ERRORS

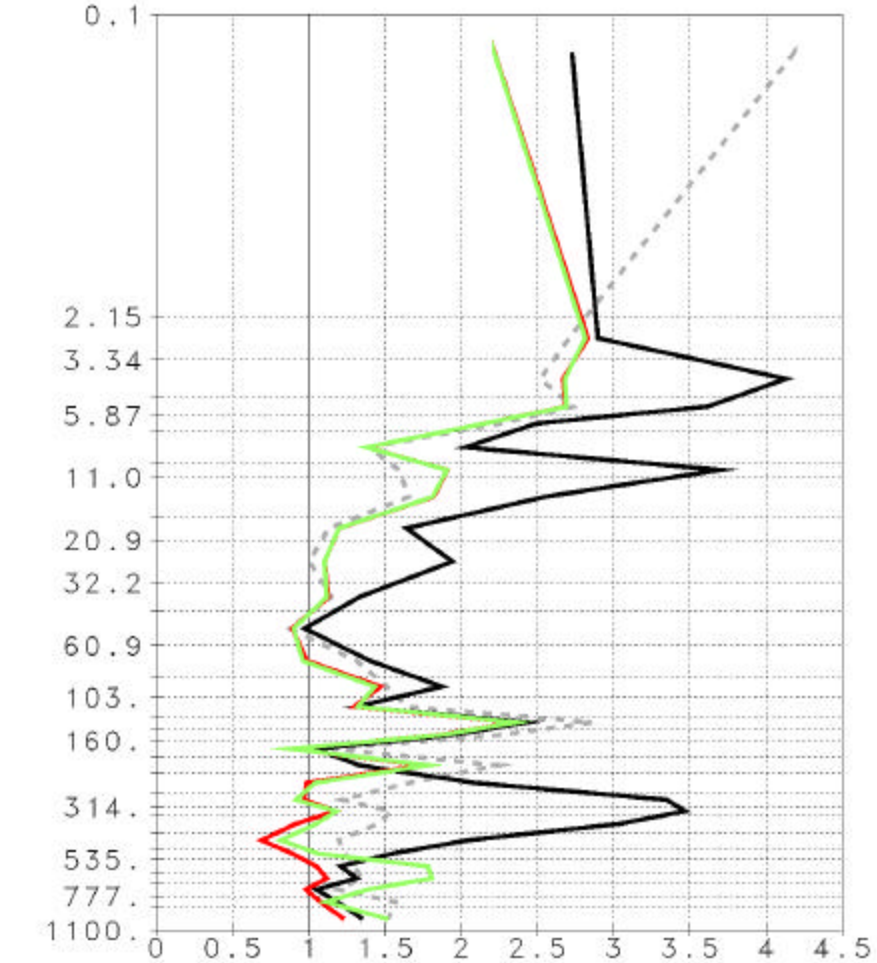
Total %	1 Km LAYER %		
10.6	33.3	Microwave Product	
12.1	36.0	Final Product	No Tuning
11.4	31.8	Final Product	A_1 Term
11.0	30.7	Final Product	A_1+B_{11} Term

Ozone Profile RMS % Errors
466 Clear Ocean Night Cases



Total O_3 %		
44.0	Climatology	
8.2	Final Product	No Tuning
11.1	Final Product	A_1 Term
10.7	Final Product	A_1+B_{11} Term

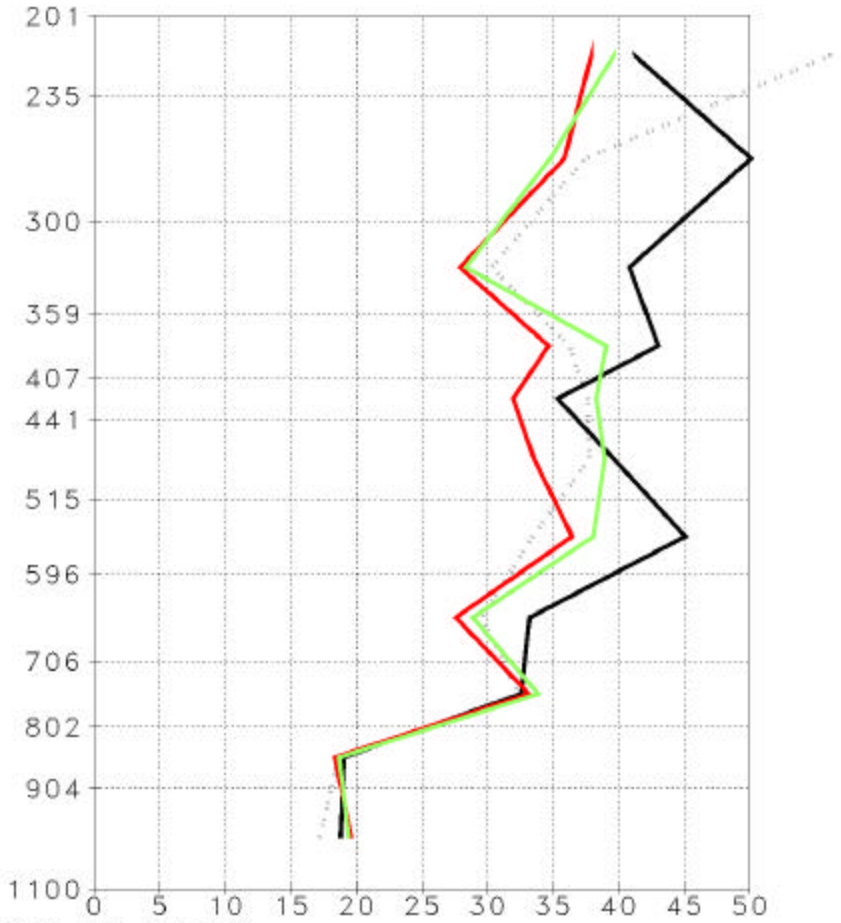
LAYER MEAN RMS TEMPERATURE ERRORS (°C)
466 Clear Ocean Night Cases



TEMPERATURE RMS ERRORS

SKIN TEMP	STATISTICS trop	700-surf	
3.37	1.59	1.43	Microwave Product
1.98	1.86	1.20	No Tuning
1.45	1.20	1.09	All Channels
1.45	1.37	1.34	A+B Temp and Surface Temp Only

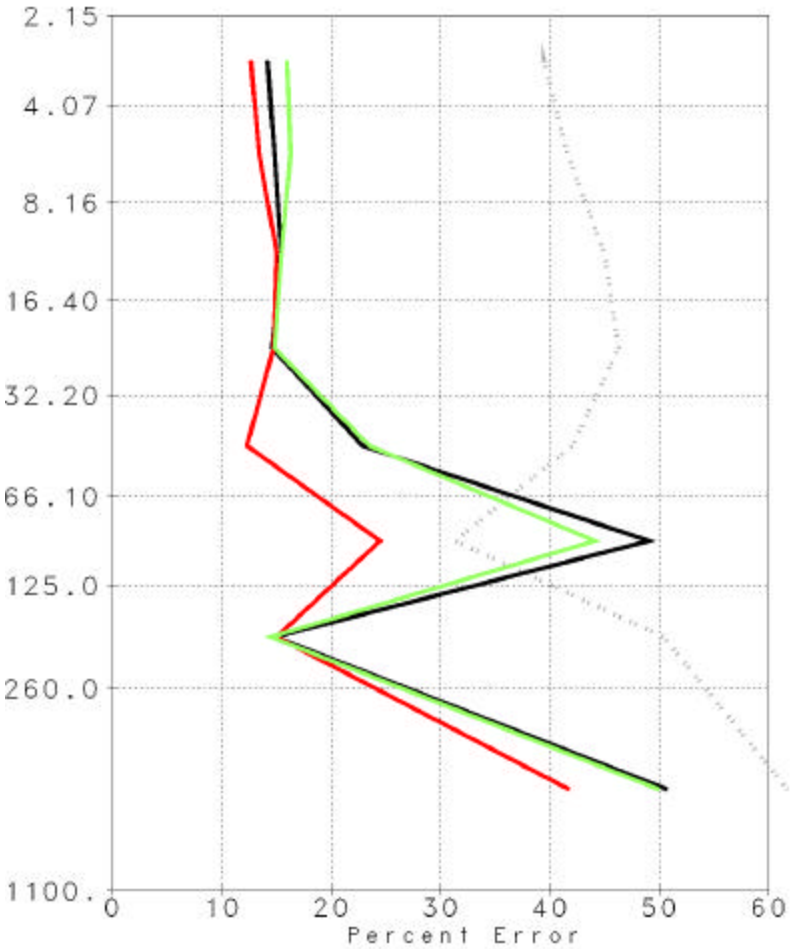
1 Km LAYER PRECIPITABLE WATER PERCENT ERRORS
466 Clear Ocean Night Cases



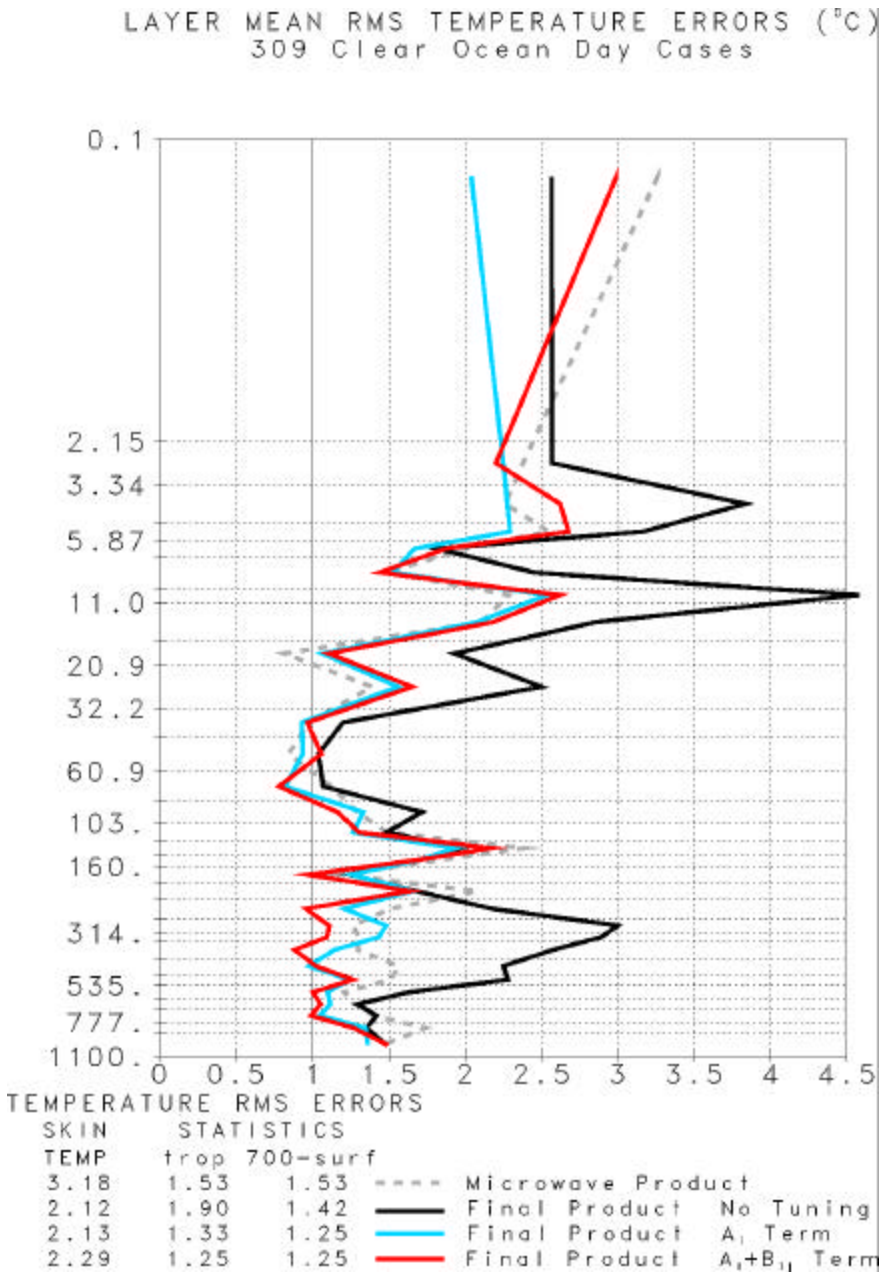
WATER RMS ERRORS

Total %	1 Km LAYER %	
10.6	33.3	Microwave Product
11.9	36.3	No Tuning
11.1	30.6	All Channels
11.5	32.5	A+B Temp and Surface Temp Only

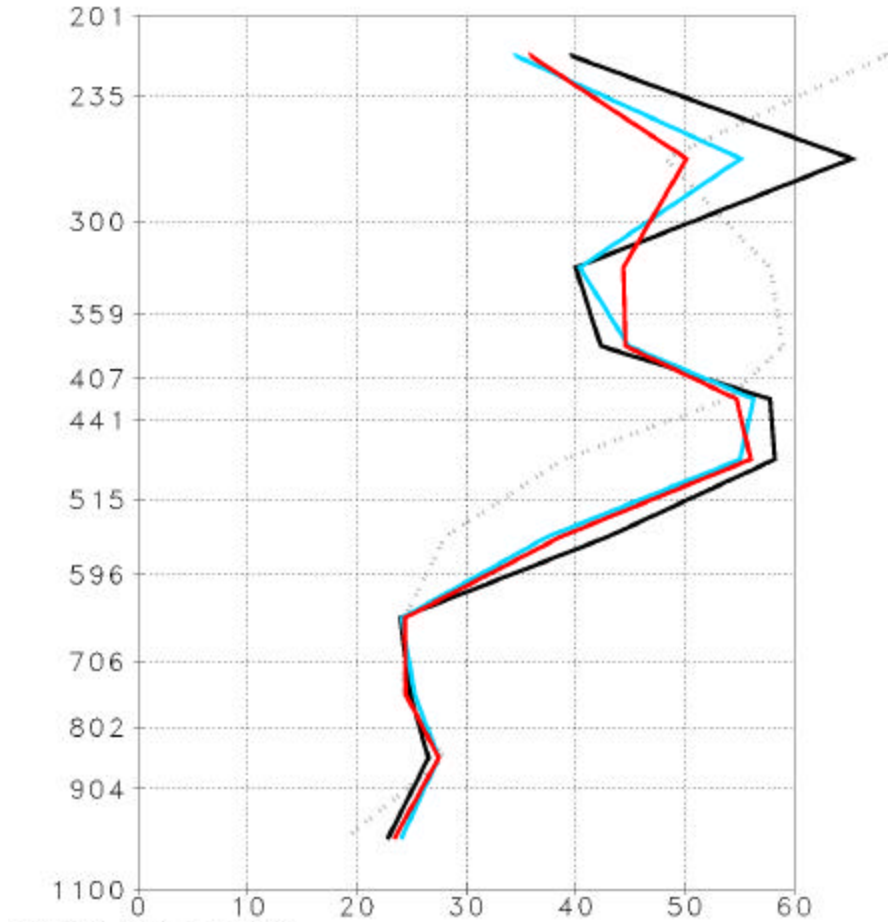
Ozone Profile RMS % Errors
466 Clear Ocean Night Cases



Total O_3 %		
44.0		Climatology
8.1		No Tuning
10.7		All Channels
8.7		A+B Temp and Surface Temp Only


LAYER MEAN RMS TEMPERATURE ERRORS (°C)
309 Clear Ocean Day Cases
0.1
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
TEMPERATURE RMS ERRORS
SKIN TEMP
STATISTICS
trop 700-surf
3.18 1.53 1.53 Microwave Product
2.12 1.90 1.42 Final Product No Tuning
2.13 1.33 1.25 Final Product A1 Term
2.29 1.25 1.25 Final Product A1+B11 Term

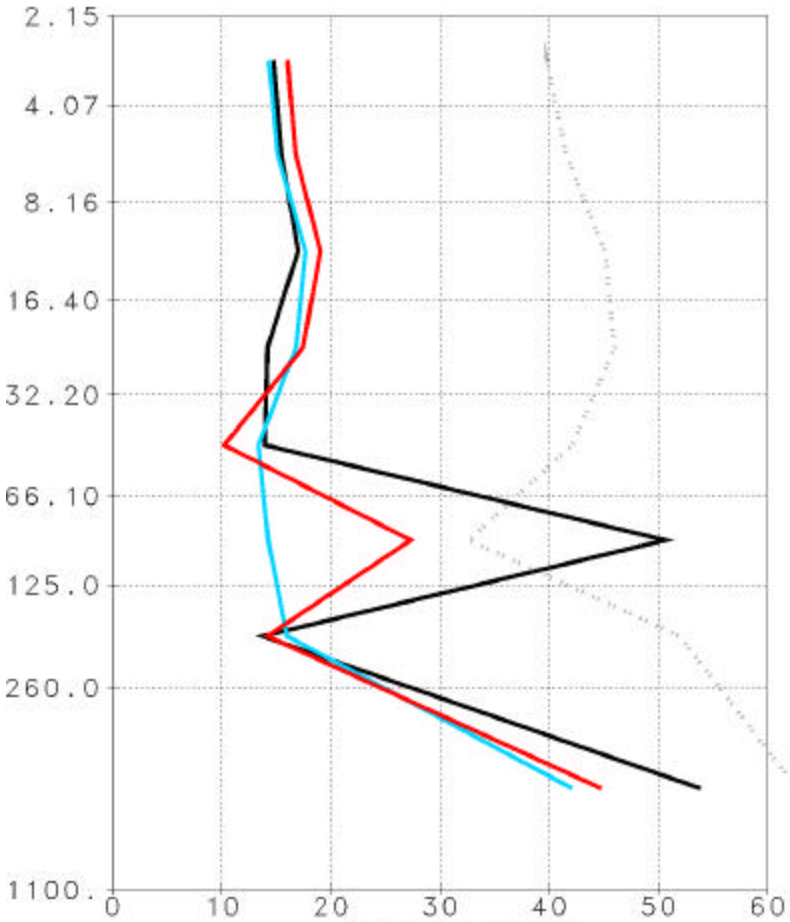
1 Km LAYER PRECIPITABLE WATER PERCENT ERRORS
309 Clear Ocean Day Cases



WATER RMS ERRORS

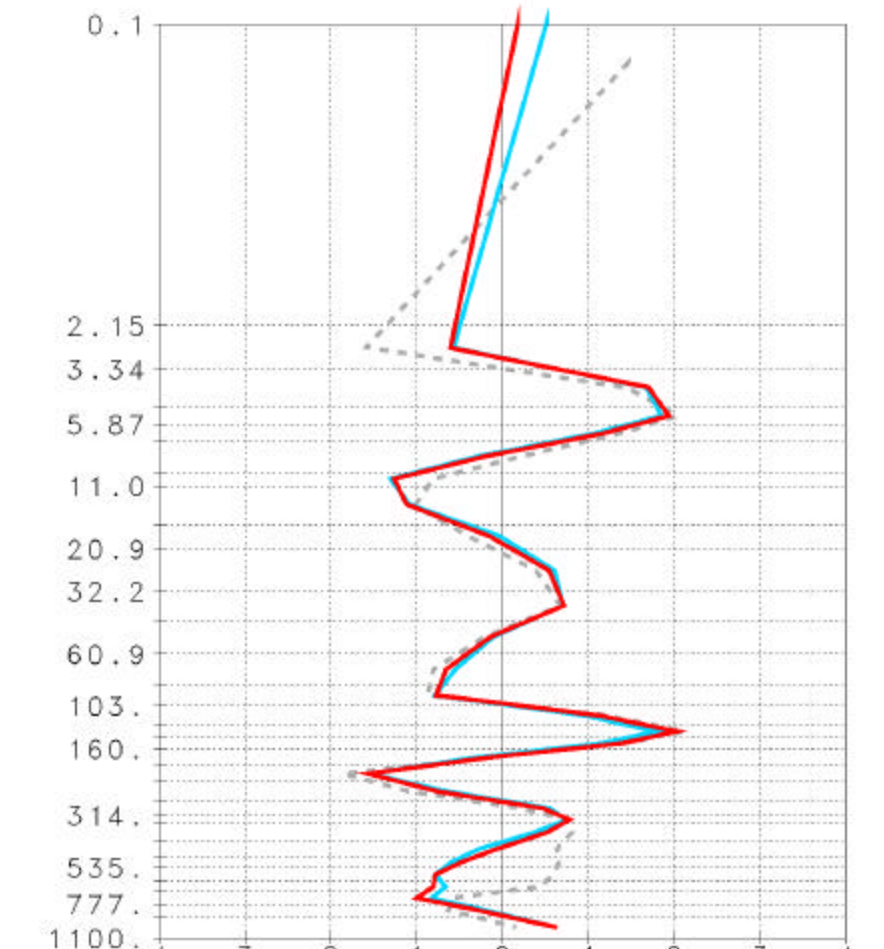
Total %	1 Km LAYER %			
13.8	40.9	----	Microwave Product	
14.7	40.4	——	Final Product	No Tuning
14.0	38.6	——	Final Product	A_1 Term
14.1	38.5	——	Final Product	A_1+B_{11} Term

Ozone Profile RMS % Errors
309 Clear Ocean Day Cases



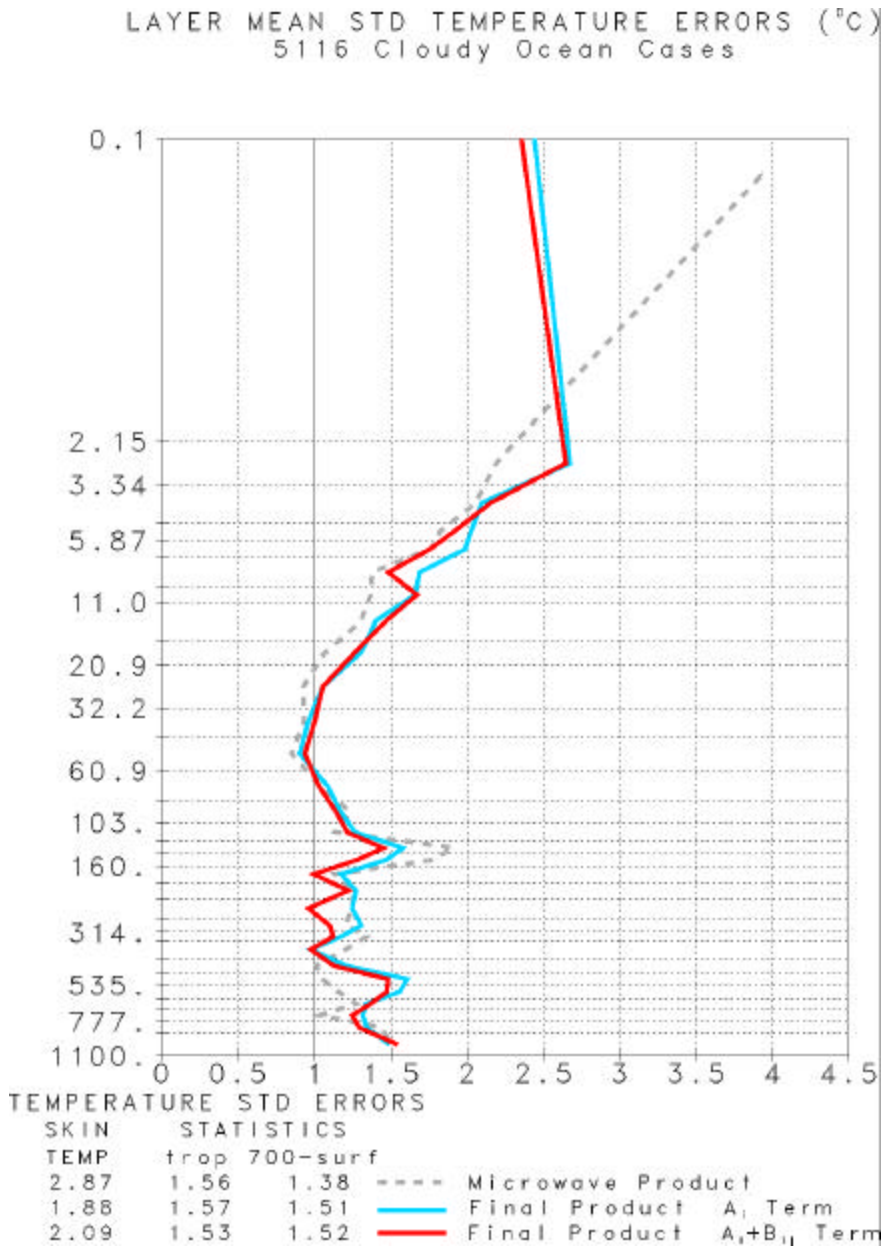
Total O_3 %			
44.0	----	Climatology	
8.4	——	Final Product	No Tuning
14.0	——	Final Product	A_1 Term
13.4	——	Final Product	A_1+B_{11} Term

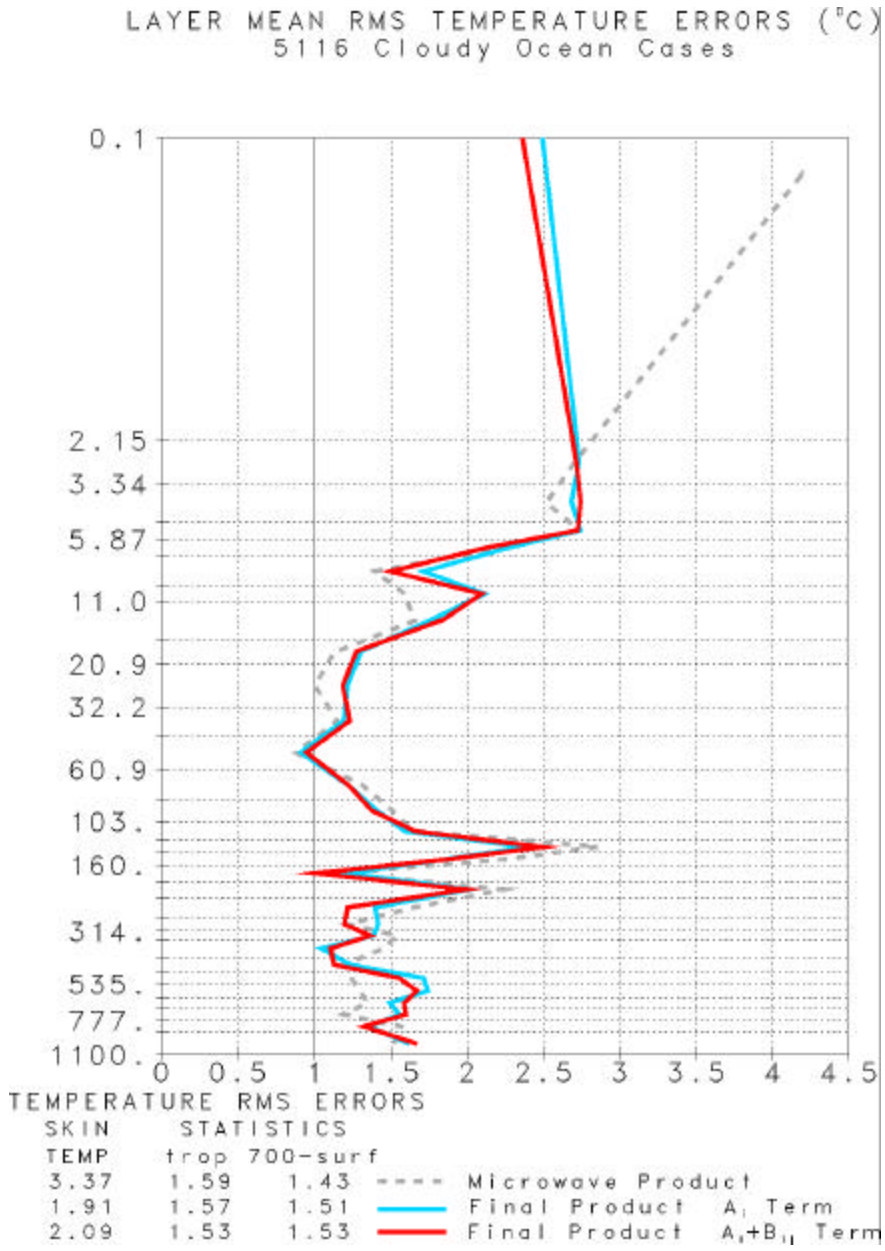
LAYER MEAN BIAS TEMPERATURE ERRORS (°C)
5116 Cloudy Ocean Cases



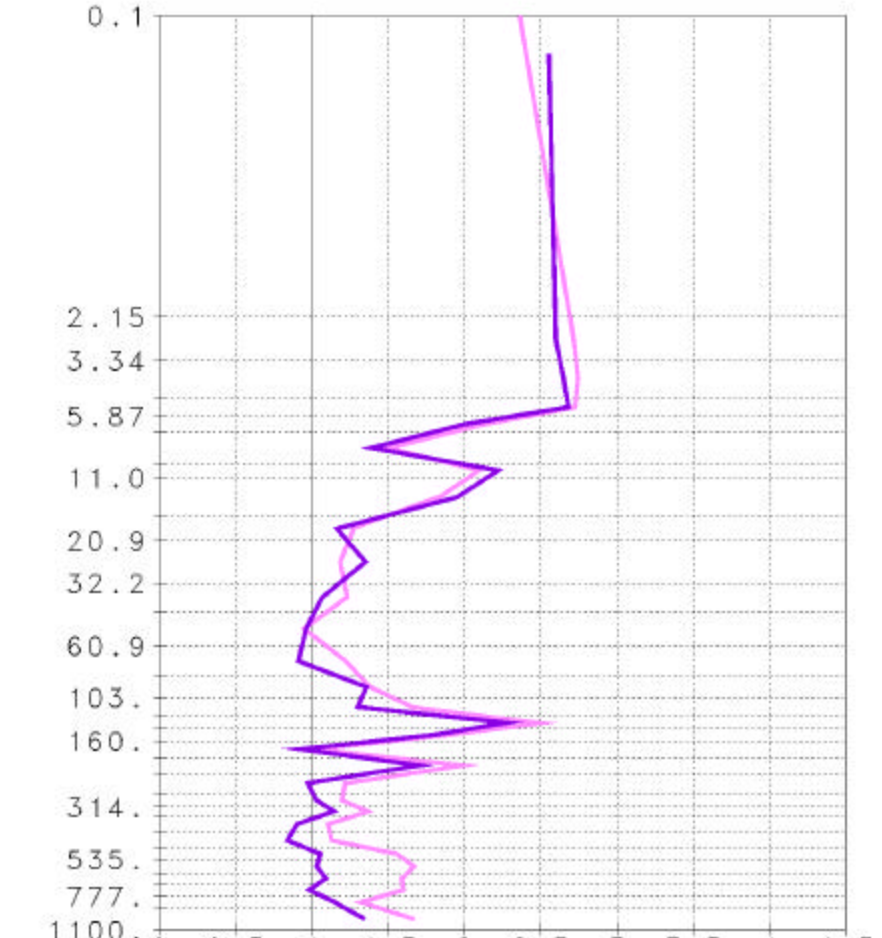
TEMPERATURE BIAS ERRORS

SKIN TEMP	STATISTICS trop	700-surf	
−1.77	0.29	−0.35	Microwave Product
−0.31	0.03	−0.13	Final Product A_1 Term
0.09	0.07	−0.22	Final Product A_1+B_{11} Term


LAYER MEAN STD TEMPERATURE ERRORS (°C)
5116 Cloudy Ocean Cases
0.1
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
TEMPERATURE STD ERRORS
SKIN TEMP
STATISTICS
trop 700-surf
2.87 1.56 1.38
1.88 1.57 1.51
2.09 1.53 1.52
Microwave Product
Final Product A1 Term
Final Product A1+B11 Term


LAYER MEAN RMS TEMPERATURE ERRORS (°C)
5116 Cloudy Ocean Cases
0.1
2.15
3.34
5.87
11.0
20.9
32.2
60.9
103.
160.
314.
535.
777.
1100.
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
TEMPERATURE RMS ERRORS
SKIN TEMP
STATISTICS
trop 700-surf
3.37 1.59 1.43
1.91 1.57 1.51
2.09 1.53 1.53
Microwave Product
Final Product A1 Term
Final Product A1+B11 Term

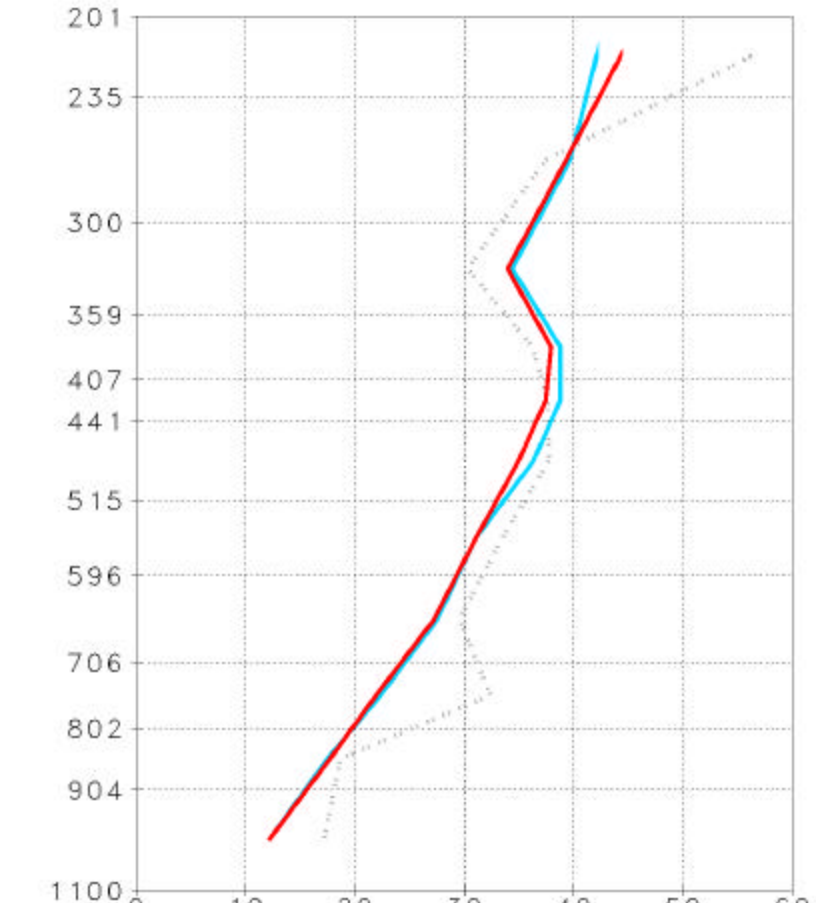
LAYER MEAN RMS TEMPERATURE ERRORS (°C)



TEMPERATURE RMS ERRORS

SKIN TEMP	STATISTICS trop	700-surf	
2.09	1.53	1.53	Cloudy Cases
1.83	1.22	1.16	Clear Cases

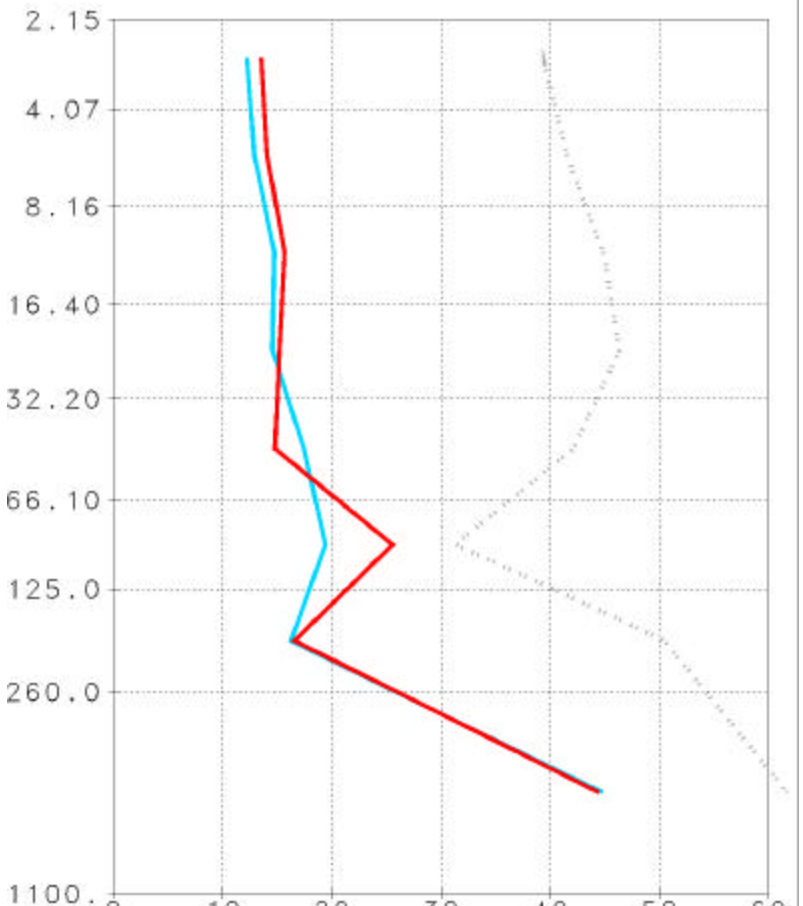
1 Km LAYER PRECIPITABLE WATER PERCENT ERRORS
5116 Cloudy Ocean Cases



WATER RMS ERRORS

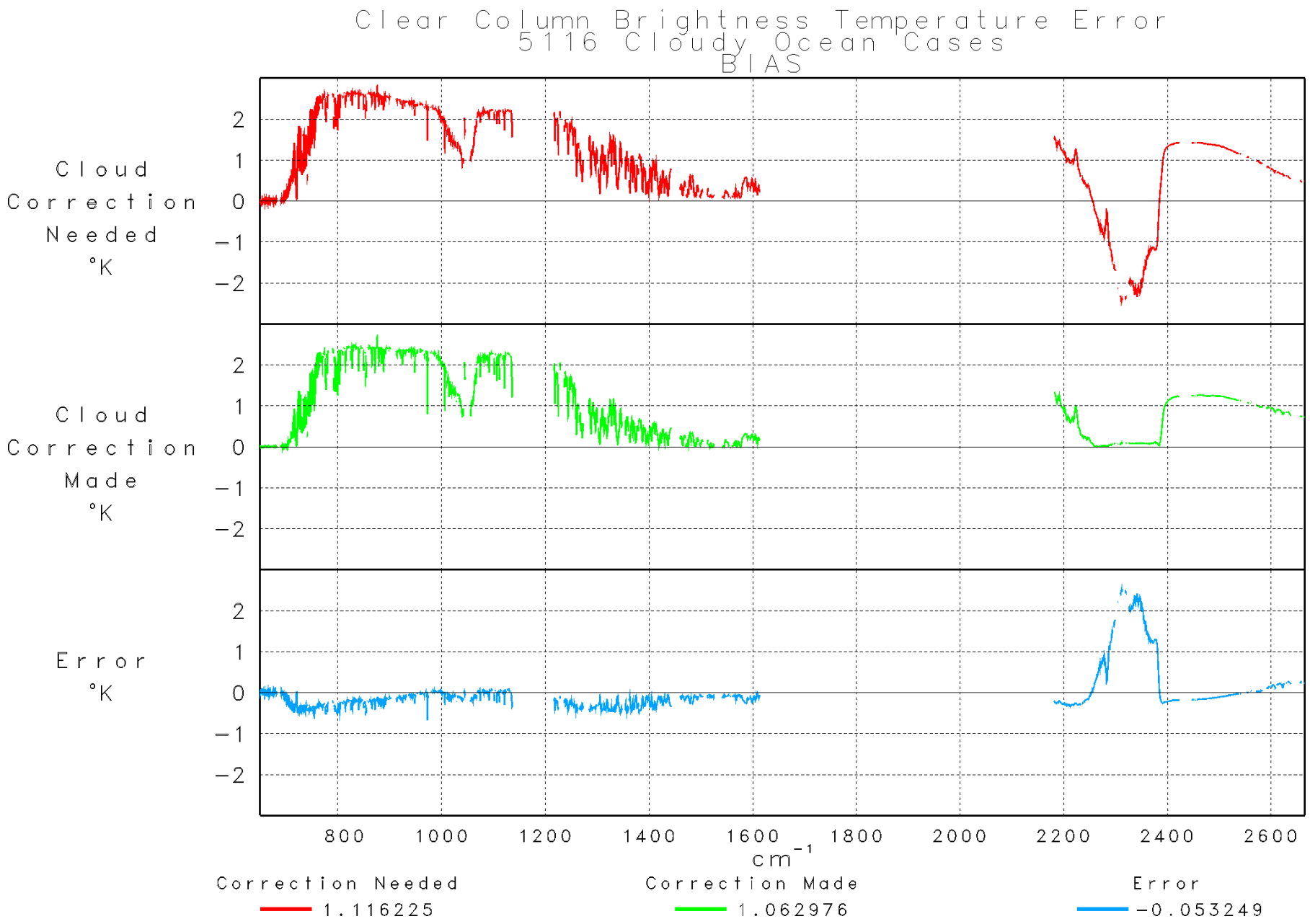
Total %	1 Km LAYER %	
10.6	33.3	Microwave Product
10.2	30.9	Final Product A_i Term
10.3	30.7	Final Product A_i+B_{ij} Term

Ozone Profile RMS % Errors
5116 Cloudy Ocean Cases

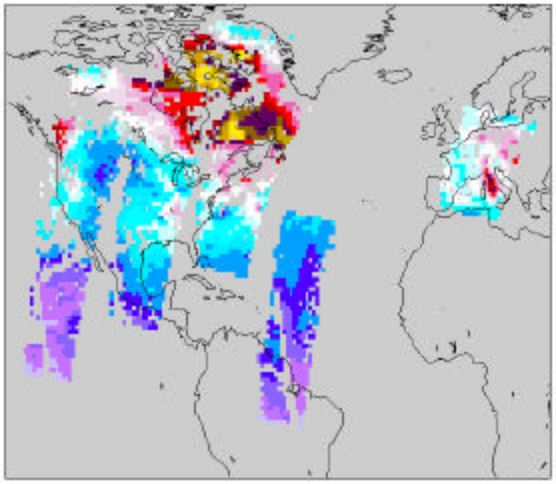


Total O_3

%	
44.0	Climatology
12.1	Final Product A_i Term
11.3	Final Product A_i+B_{ij} Term

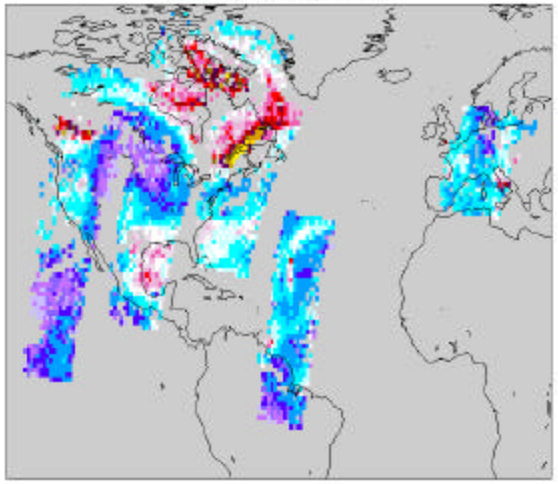

Clear Column Brightness Temperature Error
5116 Cloudy Ocean Cases
BIAS
Cloud Correction Needed °K
Cloud Correction Made °K
Error °K
2
1
0
−1
−2
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
cm⁻¹
Correction Needed
1.116225
Correction Made
1.062976
Error
−0.053249

TOMS OZONE (DU)
July 19, 2002 11:06 AM



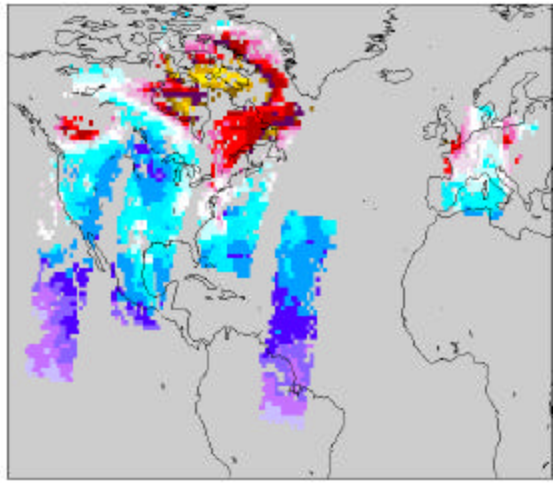
260 281 302 323 344 365 386
AREA MEAN = 312.10 STANDARD DEV= 27.92

AIRS OZONE (DU)
July 20, 2002 1:30 AM
Multiplied by 1.12



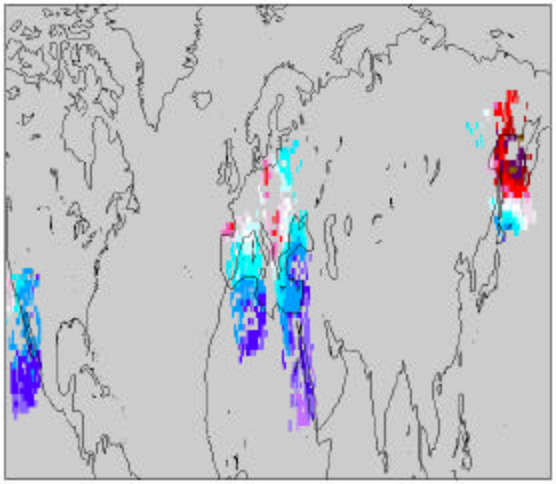
260 281 302 323 344 365 386
AREA MEAN = 308.54 STANDARD DEV= 24.27

TOMS OZONE (DU)
July 20, 2002 11:06 AM



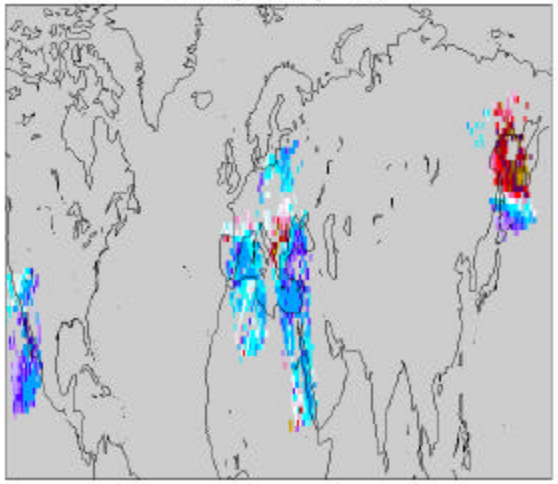
260 281 302 323 344 365 386
AREA MEAN = 310.74 STANDARD DEV= 27.18

TOMS OZONE (DU)
July 20, 2002 11:06 AM



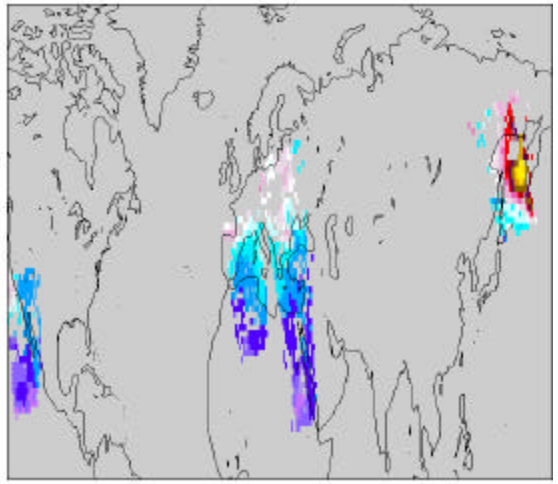
260 281 302 323 344 365 386
AREA MEAN = 311.51 STANDARD DEV= 26.21

AIRS OZONE (DU)
July 20, 2002 1:30 PM
Multiplied by 1.12



260 281 302 323 344 365 386
AREA MEAN = 310.63 STANDARD DEV= 28.05

TOMS OZONE (DU)
July 21, 2002 11:06 AM



260 281 302 323 344 365 386
AREA MEAN = 310.53 STANDARD DEV= 26.75

DIFFERENCES FROM WHAT IS CURRENTLY AT JPL

Channel noise covariance matrix at JPL does not contain estimate of computational error

Will be less important but maybe non-negligible with new RTA

IR tuning methodology is different from that of Larry McMillin running at JPL

Tuning need not be iterated - it does not depend on cloud cleared radiances

Constant term A_i is probably a subset of Larry McMillin's tuning matrix

Matrix B_{ij} is not, unless microwave observations Θ_j are added to tuning matrix

Need for IR tuning will be considerably less once new RTA is generated

A_i may be sufficient - may not even be necessary

NEAR TERM PLANS

We finally have new computer - can analyze a whole day

Once new RTA is generated

- We will reassess need for IR tuning; A_i, B_{ij}
- We will implement latest version of first product regression
- We will assess utility of 4.3 micron channels: at night; during day

We will implement capability to run off match-up files

- Compare to radiosondes
- Optimize retrievals

We will continue “convergence testing” to insure GSFC and JPL code produce equivalent results